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AUTHOR Gibbs, William J.; Cheng, He Ping
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ABSTRACT

This paper discusses a formative evaluation method by which to assess World-Wide-Web (WWW) documents. Also presented are the results from a pilot evaluation which examined users' interactions with Web documents and the effects of providing "document maps" to guide users to specific information. A video-split screen technique was used to record users interacting with the WWW and to assess the design of associated documents. Three female and two male subjects participated in the study; four were undergraduate students and one was a graduate student. Subjects were given two tasks: (1) to browse through the WWW and locate specific information/documents; and (2) to use and assess Eastern Illinois University's Department of Media Services Web site. At the completion of the session, subjects filled out a survey which collected information on their reactions toward the usefulness of the "document maps" and data related to their computer experience and knowledge of the WWW. Results indicated that the video-split screen method can be an effective means to assess WWW documents. Subjects need to be shown that a "document map" exists for their use and they must be explicitly informed as to its purpose and function. As WWW is used for the delivery of instruction, it is important to provide learners with a means of instructional support. Three figures present sample transcripts from the evaluation sessions and depict the time spent searching (by trials) and the number of times maps were used (by trial). (Contains 18 references.) (AEF)

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Formative Evaluation and World-Wide-Web Hypermedia

William J. Gibbs

He Ping Cheng

Introduction

Hypermedia programs are computer-based software systems for organizing and storing information. They are structured as an arrangement of nodes (concepts in text or graphical form) and links (semantic relationships between concepts), and allow users to obtain mediated experiences non-sequentially based on individual need and interest (Kumar, Helgeson & White, 1994). Users can create unique lesson structures reflective of individual learning requirements (Park & Hannafin, 1993). Early computer-based learning programs often forced users to page sequentially through information one screen at a time from beginning to end. Today's hypertext and hypermedia programs, on the other hand, typically provide clickable objects (e.g., text, pictures, etc.) as a means to access additional and/or related information. For educational purposes, these environments have the potential to represent knowledge (Bower & Hilgard, 1981). Accordingly, they may help to facilitate information encoding and retrieval (Park & Hannafin, 1993) and more appropriately serve human information processing needs.

Proponents assert that hypermedia programs are ideal for adaptive instruction. They contend that students can discern which information to study and thus can organize it to match their cognitive learning capabilities (Park, 1991). While hypermedia programs provide greater learner control, a well-cited problem with these environments is that users frequently "get lost" or disoriented (see Conklin, 1987; Neilson, 1989; Edwards and Hardman 1989). As the number of nodes and the complexity of their linkages in the hypermedia program increase, it is not unusual for the users of a complex hypermedia program to get lost in the middle of the program (Park, 1991). As Stanton and Baber (1994) point out, the phenomenon of getting "lost" can take several forms: users not being able to find required information or becoming disoriented, losing their way or being unable to formulate appropriate actions. This problem is fundamental to the design of hypermedia programs. It may be compounded in networked environments such as the World-Wide-Web (WWW) which have the capability to expand access world-wide presenting users with a seemingly infinite number of nodes and links.

While world-wide hypermedia systems are having tremendous impact on information access and retrieval, their development, it seems, is often influenced more by the technological capabilities of

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computers rather than by visual and interface design principles. Such environments are frequently designed as scrambled, content-free information or gibberish and more complex systems being developed appear to compound this problem (Stanton & Baber, 1994). Technologically, developers have the capability to include pictures, text, audio and video in documents and to almost instantaneously link to sites throughout the world. However, design protocols often differ from one site to the next which can confuse users and increase the possibility of them getting disoriented or "lost". For example, browsers of the World-Wide-Web are likely to find many dissimilar home page designs. While "web browsers" (e.g., Netscape, Mosaic) provide navigational options, home page developers often add navigational elements which confuse and mislead users and are not consistent from one site to the next. Developers should attempt to understand how users browse information and how the design of documents influences user navigation.

Purpose of the Paper

Complex interactive hypermedia pose significant challenges for those researching its effect on users (Gay & Mazur, 1993). For example, it is no simple task to design a world-wide access hypermedia system which all users find intuitive and easy to use. Understanding how users interact with these systems is important because their success is often contingent on an appropriate human-computer interface. However, while powerful from an information processing perspective, flexible, non-sequential, user-centered designs make it more complex to examine how users interact with a system (Gay & Mazur, 1993). Moreover, as the utilization of media objects such as video, audio, and animation increases, so does the difficulty of designing an effective user interface (Wadlow, 1990, p. 181).

To better understand the human-computer interface, recent formative evaluation approaches have taken a more holistic view (Winograd & Flores, 1986). Many approaches advocate qualitative methodologies (Card, Moran & Newell, 1983) using multiple data collection instruments (Marchionini, 1990) in an attempt to develop an understanding of how computer-based systems are used. The video-split screen (Gibbs & Shapiro, 1994) is one such technique for monitoring the interactions between user and computer. This method video records subjects' actions and decisions in a program, their verbal commentary and elaboration, their observations, and nonverbal and attitudinal reactions. Through a video effects generator, two images (subject and computer screen) are integrated so that the subject's behavior can be observed simultaneously with the computer screen. Subject and computer screen are each simultaneously video-recorded. This technique provides a permanent visual and auditory account of evaluation for subsequent analysis. Among other things, this data helps to identify users' reactions, needs, use patterns, and interactions and portrays, to some extent, a more fuller representation of them in the learning environment. From it, researchers can potentially design more powerful environments.

In recent years, there has been much interest in methods that help researchers understand cognition and the interplay between learners and computer-based learning environments. With techniques such as the video-split screen, a learner's interactions with a computer can be collected using multiple data collection instruments and analyzed to obtain a fuller awareness of their thought processes.

This paper discusses a formative evaluation method by which to assess World-Wide-Web documents. Also presented are results from a pilot evaluation which examined users' interactions with Web documents and the effects of providing "document maps" to guide users to specific information.

Methods

A video-split screen technique was used to record users interacting with the World-Wide-Web and to assess the design of associated documents. Three female and two male subjects participated in the evaluation sessions. Four of the participants were undergraduate students and one was a graduate student. Most of them had used the World-Wide-Web no more than three to four times prior to the evaluation sessions.

Observation Technique

Subjects were given two tasks: 1) to browse the World-Wide-Web and locate specific information/documents and 2) use and assess Eastern Illinois University's Department of Media Services Web site. On each task, subjects were asked to think aloud. They took as much or as little time as they needed. Periodically, the researchers prompted them to speak up or tell what they were thinking.

Task 1

On this task, subjects had three trials. For each trial they had to find one document located within a web site. Printouts of the documents to be found were given to the subject. The site chosen for this task was the White House; however, many other sites could have been substituted for it.

On trials 1 and 3, "document maps" were provided to assist with information searches. These maps consisted of a hierarchical breakdown (in text form only) of topics that directed subjects to the document for which they were searching. The map was positioned in a window behind the Web page and would display when clicked with the computer's mouse. No map was available for the second trial.

Task 2

For this task, subjects used Eastern Illinois University's Department of Media Services' home page and talked aloud while interacting with it. Subjects were asked to critique the home page, suggest revisions, discuss misunderstandings or provide any commentary that would contribute to improving the document. They could spend as much time or as little time as they wanted on this task.

At the completion of the session, subjects filled out a survey which collected information on their reactions toward the usefulness of the "document maps". The survey also collected data related to subjects' computer experience and knowledge of the World-Wide-Web.

Results

This was a pilot study with a small number of subjects. Given this constraint, no attempt is made to generalize the findings discussed below to other groups. Nevertheless, the study yielded informative data worthy of additional research.

It appears that the video-split screen method can be an effective means to assess WWW documents. The video recordings allowed the researchers to visually and aurally reconstruct the actions taken by subjects. This is beneficial for several reasons. First, it enables one to simultaneously monitor, among other things, how users navigate in a system, the types of options selected and the order in which they are selected. It also shows where users appear confused or where they get lost, what they like and dislike, and their observations about the program. Second, the technique allows for learners' immediate feedback about their interactions with the program. Other forms of assessment may not fully reflect a subject's instantaneous processing of stimuli or the way in which one explores and links conceptual events presented by the hypermedia system. Third, assessing a system can be a laborious task when users are asked to record/write their comments and reactions. This method of assessment removes the burden of evaluation from subjects and allows them to more easily provide feedback. Lastly, the technique permits the review and validation of observations by several

reviewers. Sample transcripts, resulting from the evaluation sessions, are presented in Figure 1. Transcripts made from the video recordings provide a useful resource for analyzing subject-computer interaction.

Figure 1
Structured Observation
Transcript Sample

"All this extra space and all these little pictures. They don't really draw your eye ..."

"I was just kind of wondering where I am. Uh, it looks like I started something major just by all the data going back and forth."

"I like the purple and blue, the colors are really bright, they catch your eye, it looks neat. It seems like it gets kind of repetitive, everywhere you go you end up just seeing the staff's names, the name of the staff personnel."

"I don't know what else is supposed to be on here, the interactive learning, I thought that would be a little game or something to play -- to learn how to use the computer, but it wasn't."

On three occasions, subjects were asked to find one document located within the White House WWW site. They were given printouts of the three documents and asked to locate them on the web. On the first and third trials a "document map" was provided. No map was available for the second trial.

There appeared to be differences in the way subjects reacted during search trials depending on the availability of the "documents map". In the second trial, for example, there was no map and most of the subjects showed what appeared to be impatience soon after their first few attempts to find the document failed. Three of the subjects showed uneasiness after two minutes. They looked for the information aimlessly, proceeding forward and backward through many screens and quitting the task before finding the document. Figure 2 indicates that most subjects took less time to find documents on the first and third trials (maps available) than on the second (no map available). Three subjects had 4 or more years of computer experience. Despite this computer familiarity, the search tasks, especially trial 2, posed difficulty for them. It should be pointed out, however, that experience with computers does not necessarily mean that one will be able to effectively search the Web having little prior exposure to it.

Figure 2
Time Spent Searching
(By Trials)

Trials	Minutes in Search					Total Time
	S1	S2	S3	S4	S5	
1st	07	08	09	05	12	41
2nd	14	07	25	10	15	71
3rd	08	06	03	13	02	32

Subjects stated that the "document map" was very useful when searching for documents. From observations, it appeared that subjects attempted to first find the documents without the aid of the map. However, once it was clear that the map provided a visual guide to the to-be-found documents, their use increased. Three subjects use of the "document maps" increased from the first to the third trial. Use was determined by counting the number of times subjects viewed the map on each trial. On trial 1, subjects 3, 4 and 5 used the maps a total of three times. Their use of the map increased to a total of 16 times on the third trial (see Figure 3). Subjects 1 and 2 used the map less on the third trial than on the first.

Figure 3
Number of Times Maps Were Used (By Trial)

Trial	Number of Times Map was Used					Total
	S1	S2	S3	S4	S5	
1st	05	12	00	02	01	20
3rd	03	11	07	03	06	30

During trials, subjects initially seemed to search for context and informational clues rather than visual clues and some resorted to aimlessly clicking navigation options only after all other approaches failed. This has implications for designers in that the informational content presented should be supported and/or coincide with visual cues and navigational elements. For example, while certain visual cues attracted attention, subjects also read the text on-screen and from this made inferences as to where they might find the documents for which they were searching. Thus, it was not a haphazard random process by which subjects searched for information -- the meaning of the presented information was seriously considered and directed their search efforts.

Discussion

As the World-Wide-Web is used for the delivery of instruction, it is important to provide learners with a means of instructional support. This is particularly important, given that users frequently experience disorientation within hypermedia systems. For instructional purposes, learners need information about how to find topics and concepts under study. Creating "document maps" for use with the World-Wide-Web can be a time consuming process considering the seemingly infinite number of nodes and links that could be established. However, from this pilot study its seems even the simplest of maps are useful. When a finite path is established to reach a particular topic, a simple hierarchical breakdown of the topics will be of much value to learners. It provides them with a guide and appears to prevent them from getting side-tracked by distracting information.

From this study, it was observed that subjects need to be shown that a "document map" exists for their use. They also must be explicitly informed as to its purpose and function. In some cases, it was not until several failed attempts and much frustration that subjects realized that they had the map. Therefore, for instructional purposes, such resources should be made identifiable and easily accessible to learners. It would have helped if subjects had a "Read Me First" button which informed them about the purpose of the map.

In this study, a map was provided by a separate application and was not clickable. Nevertheless, subjects made repeated attempts to click the words on the map in attempts to go to a destination. When no action resulted from their clicks, some appeared confused and experienced difficulty getting back to the search. Therefore, whenever possible, designers should provide navigational elements or clickable objects on maps so that when users click them, they are taken to the desired location.

Summary

This paper has discussed an approach for assessing World-Wide-Web hypermedia systems. Recent assessment approaches have become multifaceted and holistic in an attempt to more fully understand the human-computer interface. Data collection instruments, such as the one discussed in this paper, have the potential to provide more direct comprehensive evaluations of complex systems.

A current problem with hypermedia programs is that users frequently "get lost" when using them. Developers must consider methods to guide users to

information and to reduce the potential of them becoming disoriented. From the analysis presented, informational maps will likely increase the efficiency with which learners search for information. When designed effectively, they appear to have positive impact on students. Moreover, these maps can present the structure of to-be-learned information and thus have positive learning benefits.

Further Research

From this pilot, a more in-depth study is planned to examine the effects of maps on users' browsing behavior and cognitive processing. Using the techniques described in this paper, it may be possible to determine the effects of various types of maps and WWW interface designs on users' cognitive processing. Our knowledge of learners' thought processes in various types of computer-based learning environments is limited (Nakhleh & Krajcik, 1991). Using techniques like the video-split screen with methods to analyze subjects' verbal commentary such as protocol analysis (Ericsson & Simon, 1984) may prove useful in better understanding learners' cognitive processes while engaged in a hypermedia program. From this knowledge, more effective design may result.

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